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McDowell et al.

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(54) **APPARATUS AND METHODS FOR PROVIDING ILLUMINATED SIGNALS FROM A SUPPORT SURFACE**

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Related U.S. Application Data

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(51) **Int. Cl.**

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G08G 1/07	(2006.01)
G08B 5/36	(2006.01)
E01C 9/08	(2006.01)
F21S 9/02	(2006.01)
F21S 9/03	(2006.01)
F21V 15/01	(2006.01)
F21W 111/00	(2006.01)
F21Y 101/02	(2006.01)
F21Y 113/00	(2016.01)
F21V 23/04	(2006.01)

(52) **U.S. Cl.**

CPC . ***G08G 1/07*** (2013.01); ***E01C 9/08*** (2013.01); ***F21S 9/02*** (2013.01); ***G08B 5/36*** (2013.01); *F21S 9/037* (2013.01); *F21V 15/01* (2013.01); *F21V 23/045* (2013.01); *F21W 2111/00* (2013.01); *F21Y 2101/02* (2013.01); *F21Y 2113/005* (2013.01)

(58) **Field of Classification Search**

CPC G08G 1/07; G08B 5/36; E01C 9/08
USPC 340/907, 854.7, 870.29, 924, 925; 362/382, 384; 345/179
See application file for complete search history.

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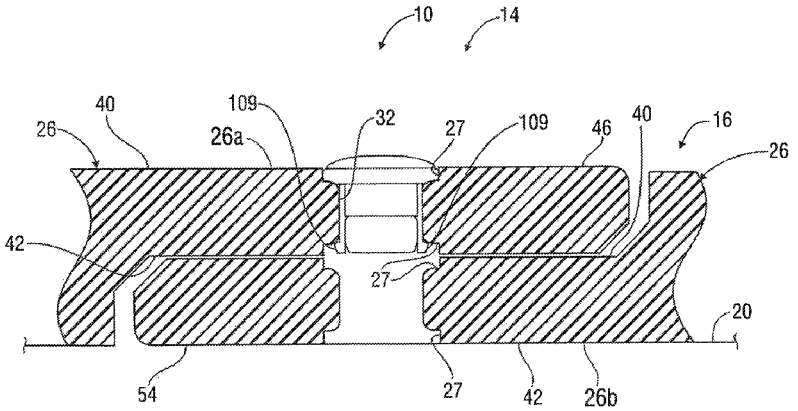
(74) *Attorney, Agent, or Firm* — E. Randall Smith; Jones & Smith, LLP

(57) **ABSTRACT**

Apparatus for providing illumination from a support surface includes a shell releasably engageable with the support surface. An electronics system is seated within the shell and projects light up and out of the shell. A power pack releasably engages the shell and electrically engages the electronics system to provide power thereto. The electrical interface between the electronics system and power pack is fluidly sealed.

19 Claims, 5 Drawing Sheets



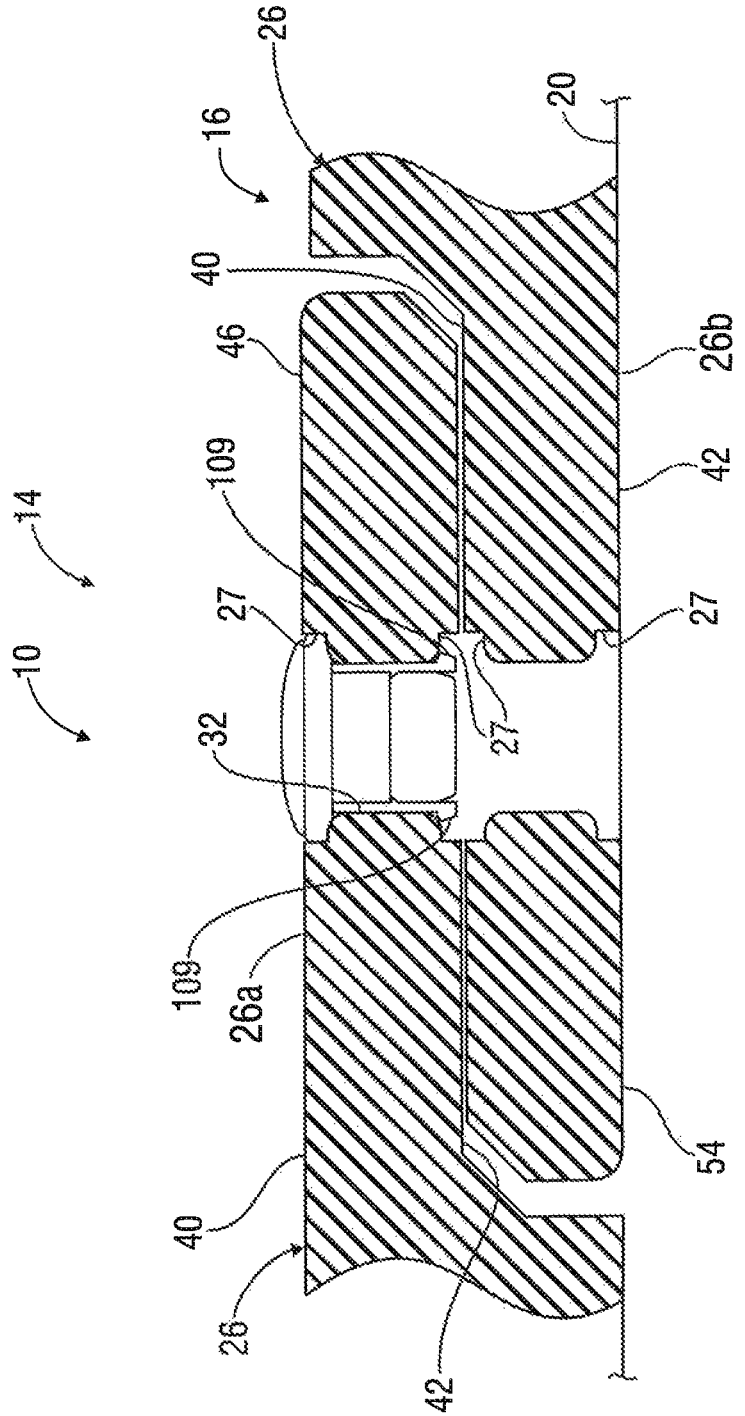


FIG. 1

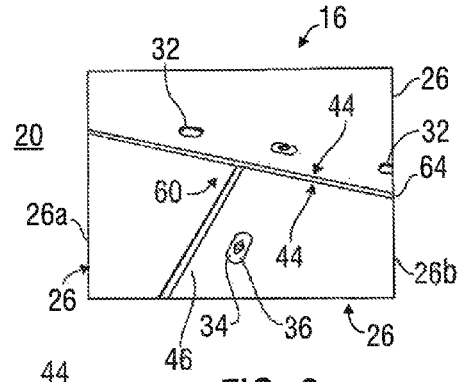


FIG. 3

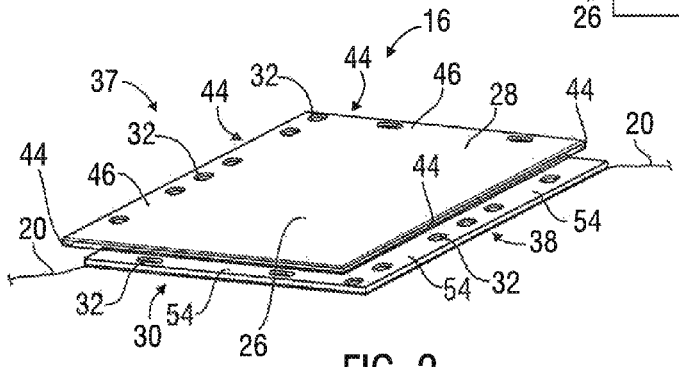


FIG. 2

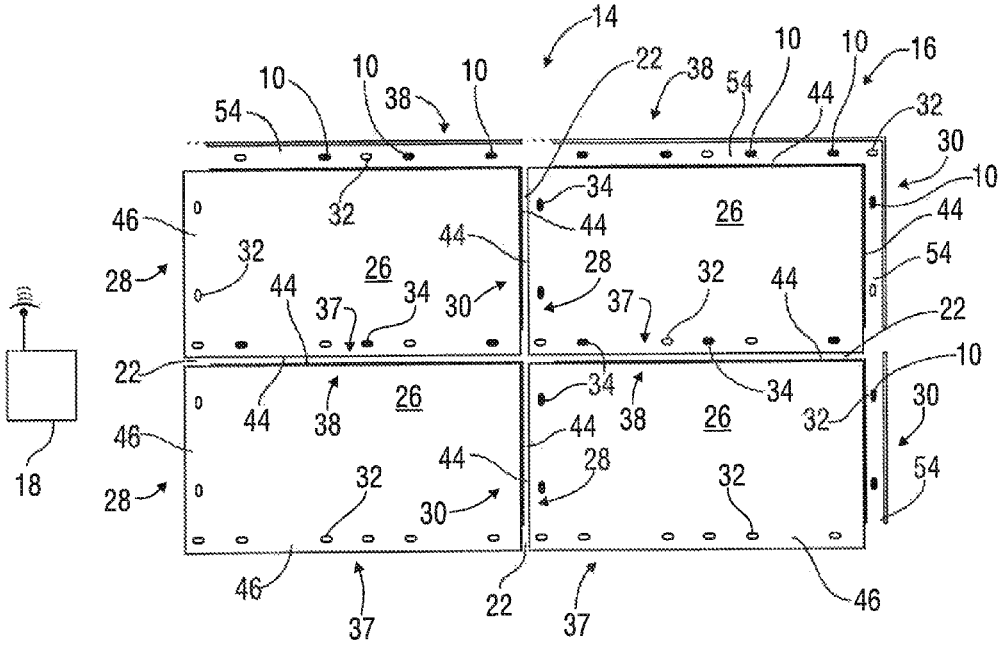


FIG. 4

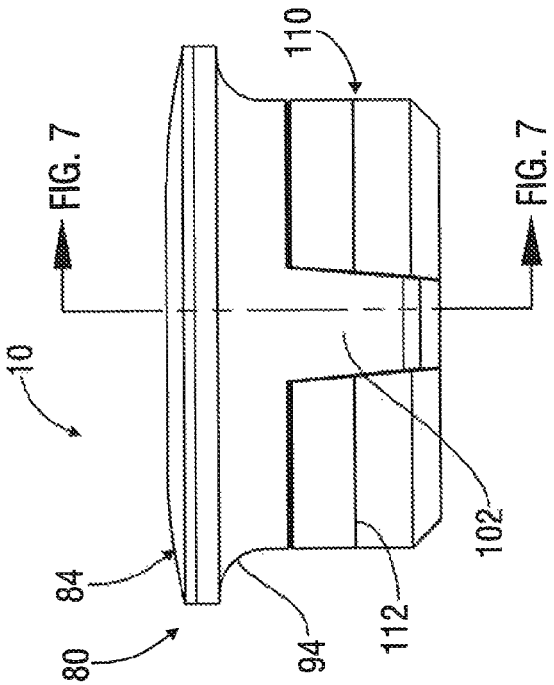


FIG. 6

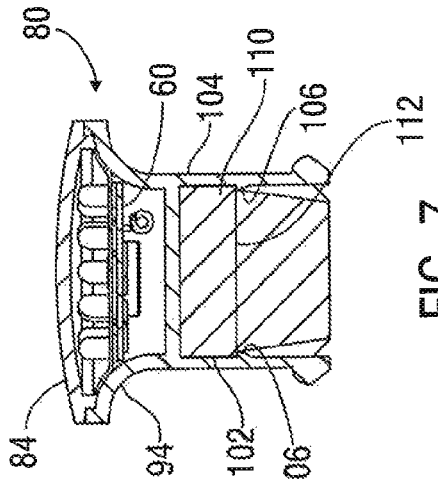


FIG. 7

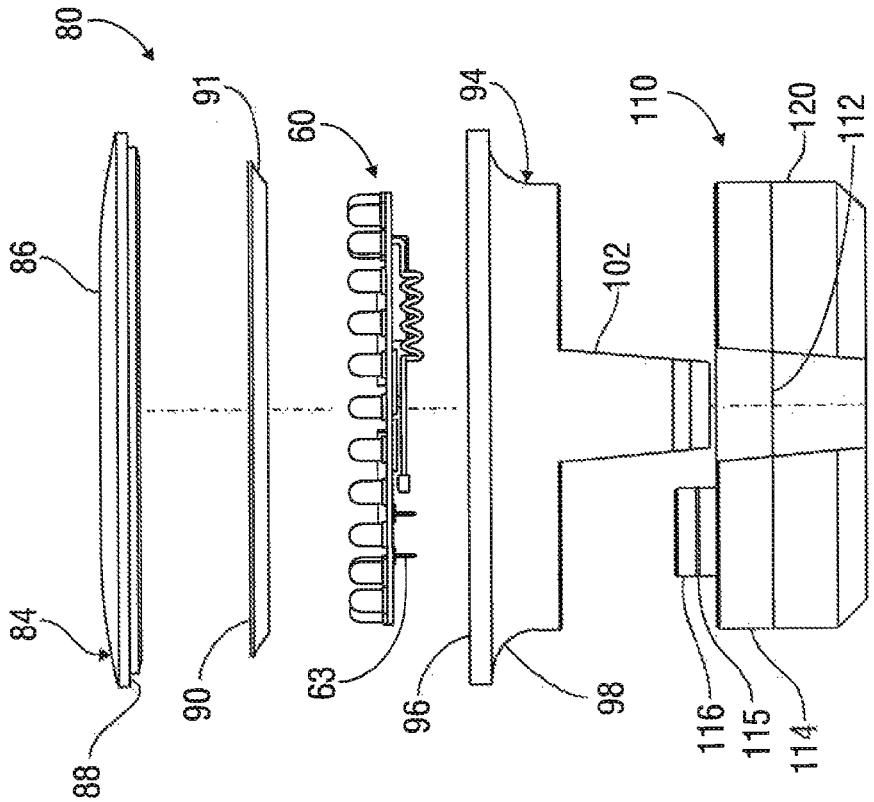


FIG. 5

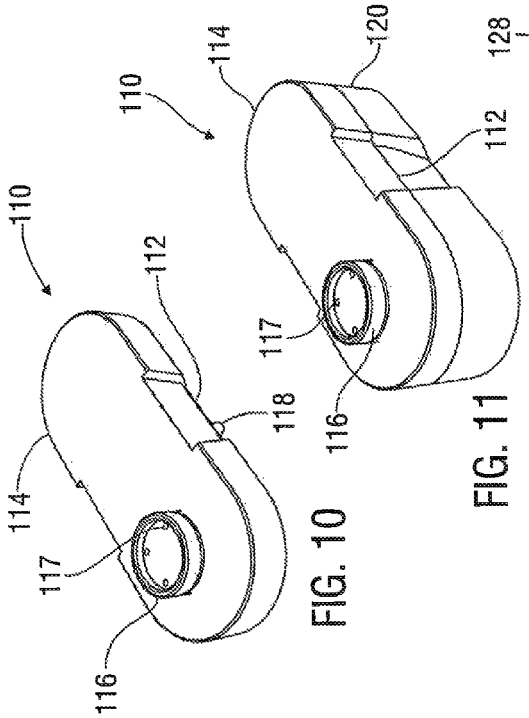


FIG. 10

FIG. 11

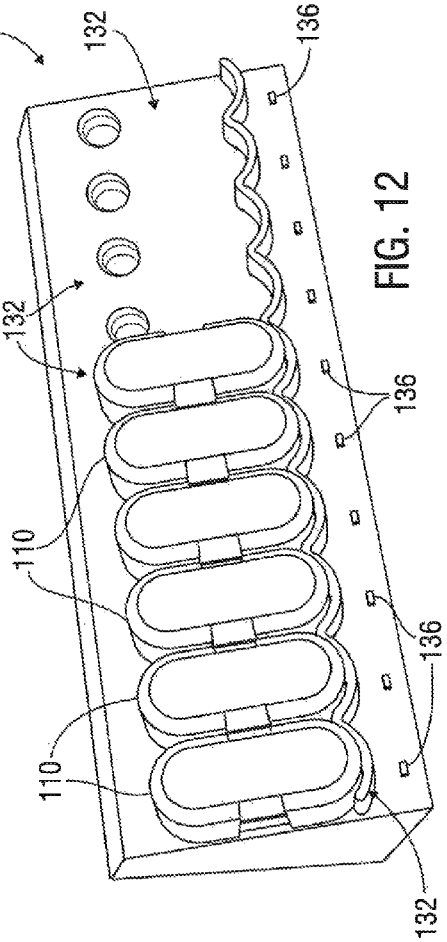


FIG. 12

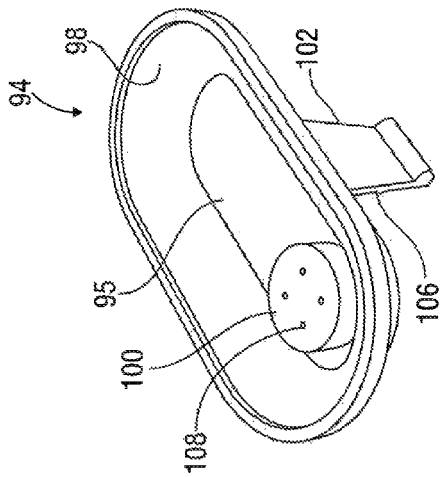


FIG. 8

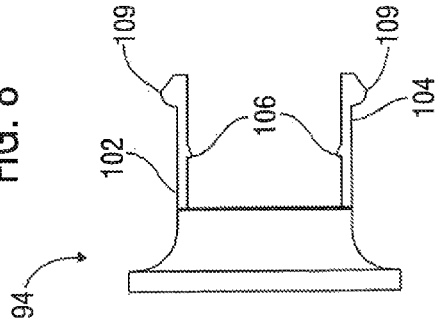


FIG. 9

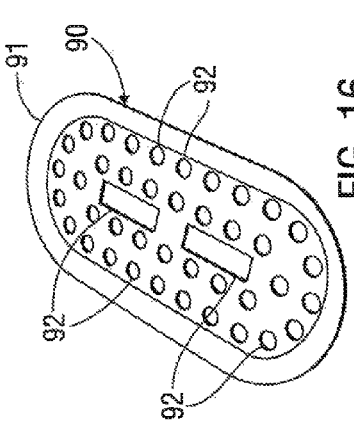


FIG. 16

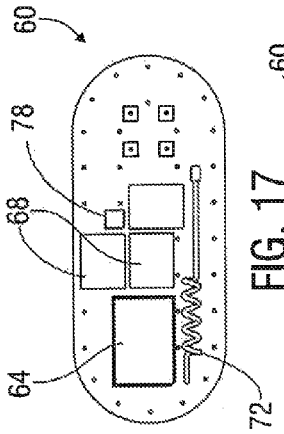


FIG. 17

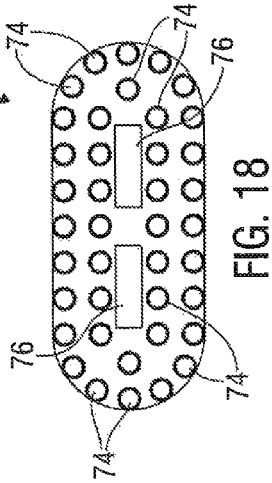


FIG. 18

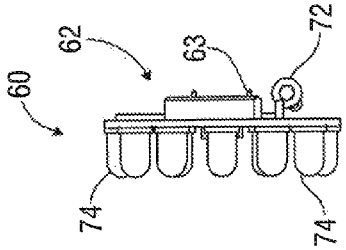


FIG. 19

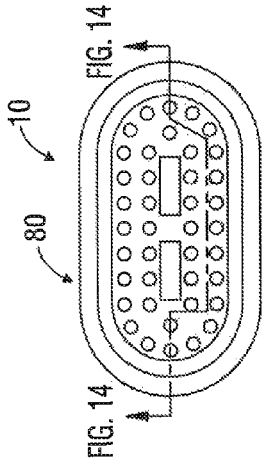


FIG. 13

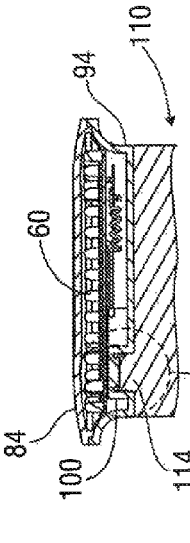


FIG. 14

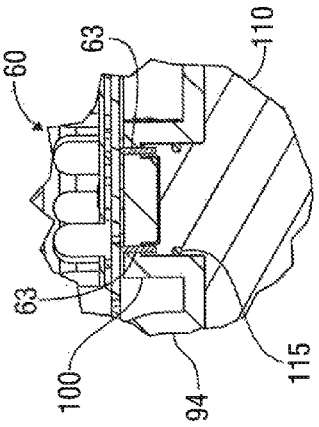


FIG. 15

APPARATUS AND METHODS FOR PROVIDING ILLUMINATED SIGNALS FROM A SUPPORT SURFACE

The present application claims priority to U.S. Provisional Patent Application Ser. No. 61/857,474, filed on Jul. 23, 2013 and entitled "Apparatus and Methods for Providing Illuminated Signals from a Support Surface", which is hereby incorporated herein in its entirety.

FIELD OF THE DISCLOSURE

The present disclosure relates to providing illuminating signals from support surfaces.

BACKGROUND

Temporary or semi-permanent support surfaces have been used for roadways, remote jobsites, industrial staging areas and the like, in an ever-increasing myriad of industries, such as the construction, military, oilfield, transportation, disaster response, utilities and entertainment arenas. These support surfaces are often made up of heavy duty, durable, all-weather, thermoplastic mats, which are reusable and interlock together to form the support surface.

In various scenarios, it may be beneficial to provide one or more illuminated signals from the support surface. For example, in some scenarios, it may be desirable to signal a driver or other equipment operator who is entering, exiting or located upon the support surface. For another example, there may be instances when it is desirable to signal other personnel on or near the support surface. The signal can have any desired purpose, such as indicating a path, boundary or environmental condition.

It should be understood that the above-described discussion is provided for illustrative purposes only and is not intended to limit the scope or subject matter of the appended claims or those of any related patent application or patent. Thus, none of the appended claims or claims of any related application or patent should be limited by the above discussion or construed to address, include or exclude each or any of the above-cited features or disadvantages merely because of the mention thereof herein.

Accordingly, there exists a need for improved systems, articles and methods useful for providing illuminated signals from a support surface having one or more of the attributes or capabilities described or shown in, or as may be apparent from, the other portions of this patent.

BRIEF SUMMARY OF THE DISCLOSURE

In some embodiments, the present disclosure involves apparatus for providing illumination from a load-supporting surface that includes at least one mat. The apparatus includes a shell releasably engageable with the mat. The shell includes a transparent upper surface, a fluid-sealed cavity and a power connection interface therein. An electronics system is configured to be disposed within the cavity of the shell and project light out of the shell through the upper surface of the shell. The electronics system includes at least one electrical connector arranged and adapted to be aligned with the power connection interface of the shell. A power pack is configured to releasably engage the shell and sealingly engage the power connection interface thereof. The power pack has at least one electrical connector arranged and adapted to be aligned with the power connection interface of the shell and electrically couple to the electrical connector of the electronics system to provide electric power thereto. A fluid tight seal is provided around the respective engaged electrical connectors.

In many embodiments, the present disclosure involves a system for providing illumination from a load-supporting surface. The system includes a plurality of portable illuminators releasably engageable with the load-supporting surface at different locations and a network coordinator. Each illuminator includes a fluid-sealed cavity therein and a wirelessly-controlled electronics system disposed within the cavity. The electronics system is configured to project light out of its respective illuminator. Each illuminator also includes a power pack for providing electrical power to the electronics system. The network coordinator is configured to wirelessly communicate with the illuminators to selectively control and vary the color, intensity and/or duration of light projected from each illuminator.

Accordingly, the present disclosure includes features and advantages which are believed to enable it to advance support surface technology. Characteristics and advantages of the present disclosure described above and additional features and benefits will be readily apparent to those skilled in the art upon consideration of the following detailed description of various embodiments and referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The following figures are part of the present specification, included to demonstrate certain aspects of various embodiments of this disclosure and referenced in the detailed description herein:

FIG. **1** is a partial cross-sectional view of an embodiment of an illuminator in accordance with the present disclosure engaged with the upper mat of a pair of exemplary overlapping mats in a load-supporting surface;

FIG. **2** is a perspective view of the exemplary mat of FIG. **1**;

FIG. **3** is a top view of a series of three exemplary interconnected mats;

FIG. **4** is a top view of an embodiment of an illumination system including multiple exemplary illuminators in accordance with the present disclosure shown used with a series of four exemplary interconnected mats;

FIG. **5** is an assembly drawing of the exemplary illuminator shown in FIG. **1**;

FIG. **6** is a side view of the exemplary illuminator shown in FIG. **5**;

FIG. **7** is a cross-sectional view of exemplary illuminator of FIG. **6** taken along lines **6-6**;

FIG. **8** is a perspective view of the shell portion of the exemplary illuminator of FIG. **5**;

FIG. **9** is an end view of the shell portion of the exemplary illuminator of FIG. **8**;

FIG. **10** is a perspective view of an embodiment of a power pack useful in the exemplary illuminator of FIG. **5**;

FIG. **11** is a perspective view of another embodiment of a power pack useful in the exemplary illuminator of FIG. **5**;

FIG. **12** is a perspective view of an exemplary battery charging system;

FIG. **13** is a top view of the exemplary illuminator of FIG. **5**;

FIG. **14** is a cross-sectional view of the exemplary illuminator of FIG. **13** taken along lines **14-14**;

FIG. **15** is an exploded view of part of the exemplary illuminator of FIG. **14**;

FIG. **16** is a perspective view of the exemplary reflector shown in FIG. **5**;

FIG. **17** is a bottom view of the exemplary electronics system shown in FIG. **5**;

FIG. **18** is a top view of the exemplary electronics system shown in FIG. **5**; and

FIG. **19** is a side view of the exemplary electronics system shown in FIG. **5**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Characteristics and advantages of the present disclosure and additional features and benefits will be readily apparent to those skilled in the art upon consideration of the following detailed description of exemplary embodiments of the present disclosure and referring to the accompanying figures. It should be understood that the description herein and appended drawings, being of example embodiments, are not intended to limit the claims of this patent or any patent or patent application claiming priority hereto. On the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the claims. Many changes may be made to the particular embodiments and details disclosed herein without departing from such spirit and scope.

In showing and describing preferred embodiments in the appended figures, common or similar elements are referenced with like or identical reference numerals or are apparent from the figures and/or the description herein. The figures are not necessarily to scale and certain features and certain views of the figures may be shown exaggerated in scale or in schematic in the interest of clarity and conciseness.

As used herein and throughout various portions (and headings) of this patent application, the terms "invention", "present invention" and variations thereof are not intended to mean every possible embodiment encompassed by this disclosure or any particular claim(s). Thus, the subject matter of each such reference should not be considered as necessary for, or part of, every embodiment hereof or of any particular claim(s) merely because of such reference. The terms "coupled", "connected", "engaged" and the like, and variations thereof, as used herein and in the appended claims are intended to mean either an indirect or direct connection or engagement. Thus, if a first device couples to a second device, that connection may be through a direct connection, or through an indirect connection via other devices and connections.

Certain terms are used herein and in the appended claims to refer to particular components. As one skilled in the art will appreciate, different persons may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not function. Also, the terms "including" and "comprising" are used herein and in the appended claims in an open-ended fashion, and thus should be interpreted to mean "including, but not limited to . . . . " Further, reference herein and in the appended claims to components and aspects in a singular tense does not necessarily limit the present disclosure or appended claims to only one such component or aspect, but should be interpreted generally to mean one or more, as may be suitable and desirable in each particular instance.

Referring to FIG. **1**, an embodiment of an illuminator **10** in accordance with the present disclosure is shown engaged with an exemplary load-supporting surface **16**. The illustrated load-supporting surface **16** is shown having adjacent mats **26** disposed upon the ground **20** or other surface or area. In this example, the load-supporting surface **16** is reusable and may be capable of supporting the weight of vehicles, equipment and/or other structures thereupon. The illustrated load-supporting surface **16** includes at least two interconnected adjacent mats **26**.

Referring to FIG. **2**, the mats **26** may have any suitable form, construction and configuration. Some examples of mats **26** which may be used in various embodiments of the present disclosure are shown and described in U.S. Pat. No. 5,653,551 to Seaux, entitled "Mat System for Construction of Roadways and Support Surfaces" and issued on Aug. 5, 1997, and U.S. Pat. No. 6,511,257 to Seaux et al., entitled "Interlocking Mat System for Construction of Load Supporting Surfaces" and issued on Jan. 28, 2003, both of which have a common Assignee as the present patent application and the entire contents of which are hereby incorporated by reference herein in their entireties. For example, the mats **26** may be 14'×8' DURA-BASE® mats currently sold by the Assignee of this patent application. The illustrated mats **26** are durable thermoplastic mats, such as the DURA-BASE® mats current sold by Applicant and useful, for example, as temporary roads, jobsites and staging areas. However, the present disclosure and appended claims are not limited to this type of mat. As used herein and in the appended claims, the terms "mat" and variations thereof include boards, mats, sheets, plates or other-shaped members desired to be connected together and constructed of any suitable material.

Referring to FIG. **2**, in the illustrated embodiment, each mat **26** is flat, or planar, and constructed of impermeable material, such as thermoplastic. The exemplary mat **26** has a rectangular shape with an opposing pair of short sides **28**, **30**, an opposing pair of long sides **37**, **38**, and an edge **44** extending along each side **28**, **30**, **37** and **38**. In this particular example, the first short side **28** and first long side **37** each have an upper lip **46** extending horizontally outwardly therefrom, forming the edge **44** and which will be typically spaced above the ground **20** or other surface. The second short side **30** and second long side **38** each have a lower lip **54** extending horizontally outwardly therefrom below the edge **44** thereof and which will typically rest on the ground **20** or other surface. The upper and lower lips **46**, **54** may have any suitable size, shape, configuration and length.

Still referring to FIG. **2**, in this example, the respective upper and lower lips **46**, **54** of different mats **26** are interconnectable with locking pins **34** (e.g. FIG. **3**) releasably securable through corresponding locking pin holes **32** formed therein. The locking pin holes **32** and locking pins **34** may have any suitable form, construction and configuration. The illustrated locking pin **34** is useful to connect, or secure together, at least first (upper) and second (lower) overlapping mats **26***a*, **26***b* (e.g. FIG. **3**). In this embodiment, the illustrated mats **26** include a plurality of locking pin holes **32**. The exemplary locking pin holes **32** have an oval-shape. Each illustrated mat **26** may include, for example, a total of sixteen locking pin holes **32**, eight holes **32** formed in each of the upper and lower lips **46**, **54**. In some embodiments, the locking pins **34** may form a fluid-tight seal around, or in, the locking pin holes **32** within which they are engaged. Some examples of locking pins **34** which may be used in various embodiments of the present disclosure are shown and described in U.S. Pat. No. 6,722,831 to Rogers et al, entitled "Fastening Device" and issued on Apr. 20, 2004, U.S. Provisional Patent Application Ser. No. 61/748,818, entitled "Apparatus and Methods for Connecting Mats" and filed on Jan. 14, 2013, and U.S. patent application Ser. No. 13/780,

350, entitled "Apparatus and Methods for Connecting Mats" and filed on Feb. 28, 2013, all of which have a common Assignee as the present patent application and the entire contents of which are hereby incorporated by reference herein in their entireties. In the example of FIG. **4**, the load-supporting surface **16** includes four overlapping mats **26** interconnected with locking pins **34** and having gaps **22** formed between their respective adjacent edges **44**.

Referring back to the example of FIG. **1**, an indentation **27** is formed in the upper and lower surfaces **40**, **42** of the respective upper and lower lips **46**, **54** of each illustrated mat **26** around each locking pin hole **32**. In this embodiment, the indentation **27** formed in the upper lips **46** of the mats **26** is also oval and configured to seat an oval-shaped enlarged head **36** (e.g. FIG. **3**) of the illustrated locking pin **34**.

It should be noted, however, that the illuminator **10** of the present disclosure is not limited to use with the above-described or referenced types and configurations of load-supporting surfaces **16**, mats **26**, locking pins **34** and locking pin holes **32**, or to the disclosures of the above-referenced patents and patent applications. Any suitable load-supporting surfaces **16**, mats **26**, locking pins **34** and locking pin holes **32** may be used. Moreover, the illuminator **10** may be used with load-supporting surfaces **16** not having mats **26**, locking pins **34** or locking pin holes **32**. Thus, the illuminator **10** of the present disclosure may be used with any type of support surface having any desired components and is not limited thereby, unless and only to the extent as may be explicitly required in a particular claim hereof and only for such claim and any claims depending therefrom.

Now in accordance with the present disclosure, referring back to FIG. **1**, the illuminator **10** is arranged and adapted to be illuminated, or provide an illuminated signal, in connection with the load-supporting surface **16**. If desired, the illuminator **10** may be part of an illumination system **14** that includes multiple illuminators **10** and control equipment relating thereto.

The illuminator **10** may have any suitable form, configuration and operation and may be associated with the load-supporting surface **16** in any suitable manner. In this embodiment, each illuminator **10** is configured to be inserted into a locking pin hole **32** of one of the mats **26**. For example, the exemplary illuminator **10** may be friction fit or snapped into the hole **32** of one mat **26** (or the upper mat **26** of a set of overlapping mats). In other embodiments, the illuminator **10** may be insertable into and extend at least partially through the corresponding aligned holes **32** of two overlapping mats **26**. However, the present disclosure is not limited to these particular arrangements. The illuminator **10** may be affixed to or associated with the load-supporting surface **16** in any other desired manner. For example, each illuminator **10** may be secured (via clip, connector, adhesive, etc.) to the side, top or other aspect of the load-supporting surface **16** or a component thereof. For another example, the illuminator **10** may be integral to, or formed as part of, the load-supporting surface **16** or a component thereof.

In the embodiment of FIG. **5**, the illuminator **10** includes an electronics system **60** that provides illumination, a housing **80** that carriers and protects the electronics system **60** and directs light from the electronics system **60** and a power pack **110** that supplies power to the electronics system **60**. The electronics system **60**, housing **80** and power pack **110** may have any suitable form, configuration and operation.

Still referring to FIG. **5**, the illustrated housing **80** includes a lens **84**, reflector **90** and shell **94**. The exemplary lens **84** and reflector **90** overlay the electronics system **60**, which is housed in the shell **94**. In this embodiment, the reflector **90** is arranged and adapted to direct light from the illuminator **10** as desired. The reflector **90** may have any suitable, form, configuration and operation and may be constructed of any suitable material. If molded from plastic, for example, the reflector **90** may be electroplated to provide sufficient reflectivity. The illustrated reflector **90** (e.g. FIG. **16**) includes an angled ridge **91** around its perimeter and a series of cut-outs **92** to be aligned over, and allow the passage of light to or from, various illuminating or light receiving components of the electronics system **60**, such as described further below. The reflector **90** may, if desired, be configured to reflect heat away from the electronics system **60** in high temperature environments.

The exemplary lens **84** is configured to assist in protecting the electronics system **60** from forces applied to the illuminator **10** from above. It may have any suitable form, configuration and operation and may be constructed of any suitable material. In many embodiments, the lens **84** may be designed with sufficient strength and other specifications to withstand loading from rolling vehicles and equipment, dropped tools and other load-bearing events and hazards occurring on the load-supporting surface **16** (e.g. FIG. **1**), as well as environmental factors, such as temperature, rain, snow, etc. If desired, the lens **84** may be sufficiently scratch resistant to avoid damage thereto during typical or expected use scenarios. For example, the lens **84** may be constructed of transparent thermoplastic material.

The lens **84** may be configured to assist the reflector **90** in directing light out of the illuminator **10**. For example, the lens **84** may have an optical design for promoting effective illumination, especially if the illuminator **10** is used during daytime hours. In this embodiment, the lens **84** includes a face **86** having a curved shape to allow the desired light projecting angles from the illuminator **10** and enhance the load-withstanding capacity of the lens **84**.

Still referring to FIG. **5**, the exemplary lens **84** is configured to sealing engage the shell **94**, such as to prevent the entry of liquids therein. In this example, the lens **84** includes a lip **88** extending around the perimeter thereof and which sealingly engages an upper perimeter edge **96** of the shell **94**. If desired, one or more suitable adhesive or sealant may be included at the interface between the lip **88** and edge **96**. In some embodiments, the lens **84** and shell **94** may be welded to provide a sealed housing **80**.

The exemplary shell **94** isolates and protects the electronics system **60** and its electrical connection to the power pack **110**. The shell **94** may have any suitable form, configuration and operation. In this example, the shell **94** includes an interior cavity **95** (e.g. FIG. **8**) within which the electronics system **60** securely seats and a hard, fluid-resistant wall **98** for encapsulating the electronics system **60**. The shell **94** may be constructed of any suitable material or combination of materials to withstand the expected forces, environmental factors and other variables acting on it and the load-supporting surface **16**. For example, the shell **94** may be constructed of thermoplastic material by injection molding.

Referring back to FIG. **1**, the exemplary shell **94** releasably engages the locking pin hole **32** of the mat **26** in any suitable manner. In this embodiment, the shell **94** includes a pair of spaced-apart legs **102**, **104** extending downwardly therefrom and each having at least one outwardly extending protrusion **109** (see also FIG. **9**) configured to engage the underside indentation **27** formed in the mat **26** below the locking pin hole **32**. In this example, the legs **102**, **104** bend sufficiently to allow a snap-fit of the protrusions **109** in the indentation **27** to securely engage the illuminator **10** to the mat **26**.

Referring now to FIGS. **6** & **7**, the illustrated shell **94** releasably engages the exemplary power pack **110** and secures its connection with the electronics system **60**. For example, the legs **102**, **104** of the shell **94** may be configured to engage or grip the power pack **110**. In this embodiment, each leg **102**, **104** includes an inwardly facing ledge **106** that grips a ridge **112** (e.g. FIG. **5**) on the outside of the power pack **110**. In this example, the ridge **112** is an outer edge of the power pack **110**. The power pack **110** may be releasably engageable with the shell **94** for ease of replacement and/or maintenance or any other desired purpose. In the present embodiment, for example, the snap-in design allows different types of power packs **110** to be used with the electronics system **60**.

It should be noted, however, in other embodiments, the power pack **110** may not be releasably engageable with the shell **94**. For example, the power pack **110** and shell may **94** be part of the same component. For another example, the power pack **110** may be integral to (or a part of) the shell **94**. One example embodiment would be a one-time use illuminator **10**, wherein the entire device can be replaced or has a limited battery recharge capability (e.g. solar assisted).

Referring to FIGS. **8** & **9**, in this embodiment, the exemplary shell **94** includes a power connection interface **100** within the cavity **95** for facilitating, isolating and/or protecting the electrical connection between the electronics system **60** and power pack **110**. The power connection interface **100** may have any suitable form, configuration, operation and construction. For example, the power connection interface **100** may be insert-molded. In this example, the power connection interface **100** has multiple (e.g. four) holes **108** that accept multiple (e.g. four) power adapter pins **63** (e.g. FIG. **5**) of the electronics system **60** and align them for engagement with corresponding socket holes **117** (e.g. FIGS. **10** & **11**) in the adapter **114** of the power pack **110**.

Referring now to FIG. **10**, the power pack **110** may have any suitable form, configuration and operation sufficient to provide the necessary power supply to the exemplary electronics system **60**. The illustrated power pack **110** includes an adapter **114** for providing power to the electronics system **60**. The exemplary adapter **114** includes an electrical connector **116** for electrical connection with the electronics system **60**. For example, the electrical connector **116** may include multiple (e.g. four) socket holes **117**. In this embodiment, as shown in FIGS. **13-15**, the connector **116** sealingly engages the power connection interface **100** of the shell **94** to assist in providing a fluid tight seal around its engagement with the electrical connector **62** or power adapter pins **63** of the electronics system **60**. For example, one or more O-ring seals **115** may extend around the connector **116** to sealingly engage the interface **100**. However, the power pack **110** may provide power to the electronics system **60** in any other suitable manner.

In some embodiments, the power pack **110** may include a cord **118** connectable with an external power source, such as a local power grid (not shown). The use of a corded power pack **110** to receive direct external power may be beneficial in various circumstances, such as for long term and/or continuous use of the illuminator **10**. A corded-version of the power pack **110** may require power conversion electronics (not shown) to meet device input requirements, as are and become further known in the industry.

Now referring to FIG. **11**, the power pack **110** may instead, or also, be battery-powered. For example, the power pack **110** may include one or more batteries **120** that are releasably engageable with a battery housing, or adapter **114**, such as by snap-fitting. Any suitable type and configuration of battery **120** may be incorporated into the power pack **110**. The battery specifications may depend upon the requirements of the electronics system **60**, as are and become further known in the art. The use a battery-powered power pack **110** may be useful, for example, in remote areas where a corded power source is not available or feasible. Some embodiments of the power pack **110** may have both battery powering capability and a corded option for powering the power pack **110** and, if desired, for recharging the battery.

In some embodiments, the battery **120** may be rechargeable, as is and becomes further known. If desired, referring to the embodiment of FIG. **12**, a battery charging system **128** may be used. The charging system **128** may have any suitable form, configuration and operation. In FIG. **12**, an exemplary charging system **128** is connectable to an external power source (not shown) and useful for charging a multitude of batteries **120**. The illustrated system **128** may, for example, be wall or table mounted, or have its own support structure, and be designed to accommodate a large volume of batteries **120**. The illustrated charging system **128**, for example, includes ten battery charging stations **132**. The system **128** may control all aspects of the charging cycle and indicate the condition of the battery **110** at each station **132**. In this example, a status indicator **136** is provided at each station **132**.

The electronics system **60** may have any suitable form, configuration and operation sufficient to provide the desired illumination from the illuminator **10**. Referring to FIGS. **17** & **18**, the exemplary electronics system **60** is wirelessly controlled to provide light having a selected brightness and color scheme for a selected duration and/or sequence. In this embodiment, the electronics system **60** includes an RF module **64**, one or more LED drivers **68**, an antenna **72** and multiple LED units **74**.

The illustrated LED units **74** provide the light source for the illuminator **10**. If desired, each LED unit **74** may include multiple individual LED lights, such as to provide different colors of light. For example, each LED unit **74** may include individual red, green and blue LED lights to be able to provide a wide spectrum of different colors (including white). The exemplary LED drivers **68** are used to regulate current to the LED units **74**. For example, the LED drivers **68** may be configured to boost battery power voltage to power large LED units **74**, protect the LED lights from being destroyed by current surge and ensure consistent performance of the LED lights at varying battery charge levels. If desired, brightness of the LED lights may be controlled by pulse width modulation.

Still referring to FIGS. **17** & **18**, the illustrated RF module **64** includes a wireless transceiver and microcontroller. The exemplary microcontroller interprets messages received by the transceiver and generates control signals for the LED drivers **68**. In this embodiment, the exemplary antenna **72** is used by the transceiver of the RF module **64** to receive messages. In some embodiments, the antenna **72** may also be used by the transceiver to transmit messages. The transmit and receive capabilities of the electronics system **60** may be used to support a network of illuminators **10** in the illumination system **12**.

In this embodiment, the electronics system **60** also includes an electrical connector **62** (e.g. FIG. **19**) for electrical connection to the power pack **110**. The illustrated electrical connector **62** includes multiple (e.g. four) power adapter pins **63** extending downwardly from the system **60** for engagement with the shell **94** and power pack **110**. In this example, the pins **63** receive energy from the power pack

110 during operation of the illuminator 10. If desired, the electronics system 60 may include one or more solar panels 76 (e.g. FIG. 18) to capture energy from sunlight during daytime hours and provide it to the illuminator 10. For example, the solar panels 76 may be used to supplement power to the electronics system 60 during operations and/or provide a charge to one or more battery 120 (e.g. FIG. 11) in the power pack 110. If necessary or desired, a charger circuit 78 may be included in the electronics system 60 to convert energy captured by the solar panels 76 into safe and useful energy. When solar panels 76 are included, the electrical connector 62 of the electronics systems 60 may, if desired, be used to deliver the captured energy from the solar panels 76 to the power pack 110.

The present embodiment of the illuminator 10 is assembled in a stacked arrangement and requires minimal labor for assembly. Various embodiments of the illuminator 10 are stand-alone, self-contained, portable and reusable. The exemplary illuminator 10 is designed to withstand harsh environmental conditions and industrial environments. For example, the illuminator 10 may be designed to support loads from rolling vehicles and other equipment, function across a wide range of ambient temperatures and weather conditions, and survive contact with oil and grease, submersion in water, extended ultraviolet light exposure and impact.

An exemplary illumination system 14 (e.g. FIG. 4) includes a plurality of illuminators 10 deployable at different desired locations in the load-supporting surface 16 and at least one network coordinator 18. In this embodiment, the network coordinator 18 can be an on-site or off-site computer or other wireless device that wirelessly communicates with and remotely controls the illuminators 10. If desired, the communication protocol used in the network may be selected to support standard data encryption techniques for network security and use 2.4 GHX ISM bandwith for global interoperability.

Each exemplary illuminator 10 is a portable illuminated marker that can be used to serve as a node in a secure wireless mesh network of illuminators 10. A variety of types of signals may be provided, such as, for example, by on/off sequencing or switching, lighting sequencing, color changes or light intensity changes of one or more illuminator 10. The illuminator 10 or system 14 may be used in any desired application. For example, the illuminator 10 or system 14 may be useful to signal an observer to indicate a path, boundary, environmental condition, etc. Other exemplary potential applications include perimeter markings, illuminated road lines, zone designation within a workspace, identification of dangerous areas, crew changes, alarm signals, etc. The illumination system 14 may, if desired, be a wireless mesh network of illuminators 10 that integrates wireless sensing, monitoring and alarm systems. Thus, the types of uses and applications of the illuminator 10 and illumination system 14 are not limiting upon the present disclosure.

As mentioned above, the exemplary illuminators 10 are useful with DURA-BASE® mats, which are durable thermoplastic mats currently sold by Applicant and useful, for example, as temporary roads, jobsites and staging areas. However, the illuminator 10 is not limited to use with DURA-BASE® mats, but may be used with any suitable mats, boards, sheets, plates or other-shaped members that are part of, connected to or associated with a support surface. Likewise, the illuminator 10 is not limited to use in the pin holes of DURA-BASE® mats, but may be used in any other suitable holes or orifices of any suitable support surface, or may be otherwise connected to, or associated with, any suitable support surface.

If desired, the illuminator 10 and/or illumination system 14 may be used in conjunction with technology shown and disclosed in any combination of U.S. patent application Ser. No. 13/790,916, entitled "Liquid Containment System for Use With Load-Supporting Surfaces" and filed on Mar. 8, 2013, U.S. Provisional Patent Application Ser. No. 61/888,580, entitled "Apparatus & Methods for Electrically Grounding a Load-Supporting Surfaces" and filed on Oct. 9, 2013, and U.S. Provisional Patent Application Ser. No. 61/889,171 filed on Oct. 10, 2013 and entitled "Apparatus & Methods for Sealing Around the Opening to an Underground Borehole", all of which has a common Assignee as the present application and the entire contents of which are hereby incorporated by reference herein.

Preferred embodiments of the present disclosure thus offer advantages over the prior art and are well adapted to carry out one or more of the objects of this disclosure. However, the present invention does not require each of the components and acts described above and is in no way limited to the above-described embodiments or methods of operation. Any one or more of the above components, features and processes may be employed in any suitable configuration without inclusion of other such components, features and processes. Moreover, the present invention includes additional features, capabilities, functions, methods, uses and applications that have not been specifically addressed herein but are, or will become, apparent from the description herein, the appended drawings and claims.

The methods that may be described above or claimed herein and any other methods which may fall within the scope of the appended claims can be performed in any desired suitable order and are not necessarily limited to any sequence described herein or as may be listed in the appended claims. Further, the methods of the present invention do not necessarily require use of the particular embodiments shown and described herein, but are equally applicable with any other suitable structure, form and configuration of components.

While exemplary embodiments of the invention have been shown and described, many variations, modifications and/or changes of the system, apparatus and methods of the present invention, such as in the components, details of construction and operation, arrangement of parts and/or methods of use, are possible, contemplated by the patent applicant(s), within the scope of the appended claims, and may be made and used by one of ordinary skill in the art without departing from the spirit or teachings of the invention and scope of appended claims. Thus, all matter herein set forth or shown in the accompanying drawings should be interpreted as illustrative, and the scope of the disclosure and the appended claims should not be limited to the embodiments described and shown herein.

The invention claimed is:

1. Apparatus for providing illumination from a load-supporting surface, the load-supporting surface, including at least one mat, the apparatus comprising:

a shell releasably engageable with the mat, said shell having a transparent upper surface, a fluid-sealed cavity and a power connection interface therein;

an electronics system disposed within said cavity of said shell and configured to project light out of said shell through said upper surface of said shell, said electronics system having at least one electrical connector

arranged and adapted to align with said power connection interface of said shell; and

a power pack configured to releasably engage said shell and sealingly engage said power connection interface thereof, said power pack having at least one electrical connector arranged and adapted to align with said power connection interface of said shell and electrically couple to said electrical connector of said electronics system to provide electric power to said electronics system, wherein a fluid tight seal is provided around said respective engaged electrical connectors.

2. The apparatus of claim **1** wherein the mat includes at least one locking pin hole, further wherein said shell is releasably engageable within a locking pin hole of the mat.

3. The apparatus of claim **2** wherein said shell includes at least two legs extending downwardly therefrom and configured to engage the mat when said shell is disposed in a locking pin hole thereof.

4. The apparatus of claim **3** wherein each said leg includes at least one protrusion extending outwardly therefrom, each said protrusion configured to engage the mat.

5. The apparatus of claim **4** wherein each said leg includes at least one ledge extending inwardly therefrom, each said ledge configured to releasably engage said power pack.

6. The apparatus of claim **1** wherein said shell includes a transparent lens sealingly engaged across the upper surface thereof.

7. The apparatus of claim **6** further including at least one reflector disposed within said shell over said electronics system and arranged and adapted to direct light from said electronic system out of said shell through said lens.

8. The apparatus of claim **7** wherein said power pack is engaged with said shell below said electronics system, further wherein said power pack, electronics system, reflector, lens and shell are assembled in a stacked arrangement.

9. The apparatus of claim **1** wherein said electronics system is wirelessly controlled.

10. The apparatus of claim **9** wherein said electronics system is selectively controlled to vary the color, intensity and duration of light projecting therefrom.

11. The apparatus of claim **9** wherein said electronics system includes at least one RF module, LED driver and antenna and multiple LED units.

12. The apparatus of claim **11** wherein each said LED unit includes multiple individual LED lights.

13. The apparatus of claim **11** wherein said RF module includes a wireless transceiver and microcontroller, said transceiver configured to send and receive wireless messages and said microcontroller configured to interpret received messages and generate control signals for said LED driver.

14. The apparatus of claim **9** wherein said electronics system further includes at least one solar panel configured to capture energy from sunlight during daytime hours to provide an electrical charge to said power pack.

15. The apparatus of claim **1** wherein said power pack includes at least one battery.

16. The apparatus of claim **15** wherein the apparatus for providing illumination from a load-supporting surface is self-contained, stand alone, portable and reusable.

17. The apparatus of claim **15** further including a charging system configured to charge multiple said batteries.

18. The apparatus of claim **1** wherein said power pack includes a cord for electrical connection to an external power source.

19. The apparatus of claim **1** wherein said shell is configured to withstand harsh environmental conditions, impact and loads from rolling vehicles and other equipment thereon, contact with oil and grease, submersion in water and extended ultraviolet light exposure.

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